Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A method performed by a computer for filtering interference and noise of an asynchronous wireless signal comprising the steps of:

receiving an asynchronous data vector including a spreading code;

using the received asynchronous data vector~~, updating~~ to update weight coefficients of an adaptive filter without prior knowledge of synchronization ~~of synchronization~~ of the spreading code;

using the updated weight coefficients information to determine synchronization of the spreading code; and

demodulating the output of the filter using the determined synchronization of the spreading code for obtaining a filtered data vector.

2. (Currently Amended) The method of claim 1, further comprising the step of dividing the received asynchronous data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

3. (Currently Amended) The method of claim 2, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^{\dagger} \\ \mathbf{B}_1 \end{bmatrix}, \tag{16}$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^{t}\mathbf{s}_1}$., $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17)

4. (Currently Amended) The method of claim 1, wherein the step of determining synchronization comprises the steps of:

computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left|\mathrm{Re}\{y[\hat{i}]\}\right| = \max_{k \in \{0, 1, \ldots, NS-1\}} \left|\mathrm{Re}\{y[i-k]\}\right| \qquad (30c),$$

where $y[i] = \mathbf{w}[i]^{t}\,\mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood tests in the set $Y[i]$ given by

$$Y[i] = \{ \left|\mathrm{Re}\{y[i]\}\right|, \ldots, \left|\mathrm{Re}\{y[i-NS+1]\}\right| \},$$

where N is number of chips in the spreading code ~~and~~ , S is number of samples per chip time, and $W[i]^t$ is a tap-weights' vector.

5. (Currently Amended) The method of claim 1, wherein the step of updating weight coefficients comprises the steps of:

computing maximum likelihood estimator for covariance matrix $\mathbf{R}_x[i]$

$$\hat{\mathbf{R}}_x[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}^{(m)}[i]\mathbf{x}^{(m)*}[i] = \frac{1}{L}\mathbf{X}_0[i]\mathbf{X}_0^{t}[i].$$

wherein, $\mathbf{x}^{(m)}[i]$ is an observation vector at a sampling time iT_s of the mth symbol, L is ~~approximate~~ number of independent samples of the observation vector $\mathbf{x}^{(m)}[i]$ for the initial acquisition of detector parameters, and the data is given in matrix form by

$$\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]];$$

computing estimate of $\mathbf{R}_{\mathbf{x}_1}[i]$

$$\hat{\mathbf{R}}_{\mathbf{x}_1}[i] = \mathbf{B}_1\hat{\mathbf{R}}_{\mathbf{x}_1}[i]\mathbf{B}_1^{\dagger} = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^{\dagger}[i]\mathbf{B}_1^{\dagger}$$

and estimate of cross-correlation vector $\mathbf{r}_{x1d1}$ as, $\hat{\mathbf{r}}_{\mathbf{x}_1 d_1} = \mathbf{B}_1\hat{\mathbf{R}}_{\mathbf{x}}[i]\mathbf{s}_1 = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^{\dagger}[i]\mathbf{s}_1$

;

computing $\mathbf{w}_{\mathrm{GSC}}^{\dagger}[i] = \mathbf{r}_{\mathbf{x}_1 d_1}^{\dagger}[i]\mathbf{R}_{\mathbf{x}_1}^{-1}[i]$ (29);

estimating $\hat{b}_1 = \mathbf{sgn}((\mathbf{u}_1^{\dagger} - \mathbf{w}_{\mathrm{GSC}}^{\dagger}[\hat{i}]\mathbf{B}_1)\mathbf{x}[\hat{i}])$ (35). wherein

$\mathbf{u}_1^{\dagger} - \mathbf{w}_{\mathrm{GSC}}^{\dagger}[i]\mathbf{B}_1$ (30a) is a weight vector; and

computing output $y[i] = (\mathbf{u}_1^{\dagger} - \mathbf{w}_{\mathrm{GSC}}^{\dagger}[i]\mathbf{B}_1)\mathbf{x}[i]$. (30b).

6. (Currently Amended) The method of claim 1, wherein the step of updating weight coefficients further comprises the steps of:

applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$;

applying $\hat{\mathbf{B}}_1 = \mathbf{I} - \hat{\mathbf{u}}_j\hat{\mathbf{u}}_j^{\dagger}$,where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^{\dagger}\mathbf{s}_1}$, $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17);

for $j = 1$ to $(M-1)$, computing d_j and $\mathbf{x}_j$

$$\mathbf{d}_j^{\dagger}[i] \triangleq [\hat{d}_j^{(1)}[i], \ldots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{\dagger}[i]\,\mathbf{X}_{j-1}[i],$$

$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \ldots, \mathbf{x}_j^{(L)}[i]] = \hat{\mathbf{B}}_j[i]\,\mathbf{X}_{j-1}[i]$,where $d_1[i] = \mathbf{u}_1^{\dagger}\mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N-1)$ – dimensional process with the signal removed;

computing $(j+1)$th stage basis vector $\underline{\hat{\mathbf{u}}_{j+1}[i]}$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}_j^{(m)}[i]d_j^{(m)}[i]^* = \frac{1}{L}\mathbf{X}_j[i]\,\mathbf{d}_j[i]\ \underline{\text{, where }\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\text{ is estimate of}}$$

<u>cross-correlation vector $\mathbf{r}_{x1d1}$,</u>

$$\cancel{\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|}$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}\ \underline{\text{, where }\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|};$$

computing $(j+1)$th blocking matrix $\hat{\mathbf{B}}_{j+1}$

$$\hat{\mathbf{B}}_{j+1}[i] = \mathbf{I} - \hat{\mathbf{u}}_{j+1}[i]\hat{\mathbf{u}}_{j+1}^{\dagger}[i]\ ;$$

computing $d_M^{(m)}[i]$ and setting it equal to <u>Mth error signal</u> $\in_M^{(m)}[i]$

$$\mathbf{d}_M^{\dagger}[i] \triangleq [\hat{d}_M^{(1)}[i], \ldots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^{\dagger}[i] = \hat{\mathbf{u}}_M^{\dagger}[i]\,\mathbf{X}_{M-1}[i]\ ;$$

applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i],\ \hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i]\hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, estimating variance of $d_j[i]$

$$\hat{\sigma}_{d_j}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2\ ;$$

estimating variance of <u>error signal</u> $\in_j$

$$\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i]\hat{\delta}_{j+1}^2[i]\ ;\ \text{and}$$

computing jth scalar Wiener filter $\hat{\omega}_j[i]$

$$\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}\ .$$

7. (Currently Amended) The method of claim 1, wherein the step of updating weight coefficients further comprises the steps of:

applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$ and $\mathbf{x}_0[i] = \mathbf{x}[i]$,where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^{\dagger}\mathbf{s}_1}$., $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17);

for j = 1 to (M −1), computing d_j and $\mathbf{x}_j$

$$d_j[i] = \hat{\mathbf{u}}_j^{\dagger}[i]\, \mathbf{x}_{j-1}[i]$$

$$\mathbf{x}_j[i] = \mathbf{x}_{j-1}[i] - \hat{\mathbf{u}}_j[i]\, d_j[i]$$

$$\mathbf{d}_j^{\dagger}[i] \triangleq [\hat{d}_j^{(1)}[i], \ldots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{\dagger}[i]\, \mathbf{X}_{j-1}[i],$$

$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \ldots, \mathbf{x}_j^{(L)}[i]] = \mathbf{X}_{j-1}[i] - \hat{\mathbf{u}}_j[i]\, \mathbf{d}_j^{\dagger}[i]$,where $d_1[i] = \mathbf{u}_1^{\dagger}\mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N-1)$ – dimensional process with the signal removed;

computing (j +1)th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L} \mathbf{x}_j^{(m)}[i] d_j^{(m)}[i]^* = \frac{1}{L}\mathbf{X}_j[i]\, \mathbf{d}_j[i]$,where $\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]$ is estimate of cross-correlation vector $\mathbf{r}_{x1d1}$,

$\cancel{\hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|}$

$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}$,where $\hat{\delta}_{j+1}[i] = \|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\|$;

computing $d_M^{(m)}[i]$ and setting it equal to Mth error signal $\in_M^{(m)}[i]$

$$\mathbf{d}_M^{\dagger}[i] \triangleq [\hat{d}_M^{(1)}[i],, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^{\dagger}[i] = \hat{\mathbf{u}}_M^{\dagger}[i]\, \mathbf{X}_{M-1}[i] ;$$

applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i],\ \hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i]\hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, estimating variance of $d_j[i]$, $\hat{\sigma}^2_{d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2$;

estimating variance of <u>error signal</u> $\in_j$, $\hat{\xi}_j[i] \triangleq \hat{\sigma}^2_{\in_j}[i] = \hat{\sigma}^2_{d_j}[i] - \hat{\xi}^{-1}_{j+1}[i]\hat{\delta}^2_{j+1}[i]$;

and

computing jth scalar Wiener filter by $\hat{\omega}_j[i]$, $\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}$.

8. (Currently Amended) The method of claim 1, wherein the steps of updating weight coefficients and using the updated weight coefficients further comprises the steps of:

for $k = 1$ to n, applying

$\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_0 d_0}[i] = \mathbf{s}_1$, $\hat{\mathbf{u}}^{(k)}_1[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$, and $\hat{\delta}^{(k)}_1[i] = \|\mathbf{s}_1\|$, wherein $\mathbf{x}^{(k)}_0[i]$ is the received <u>asynchronous</u> data vector, s_1 is a designated sender's spreading code, and k is kth clock time, where $k=1$ is the first time the data is observed ;

for $j=1$ to $(M-1)$, applying

$d^{(k)}_j[i] = \hat{\mathbf{u}}^{(k)}_j[i]^\dagger\, \mathbf{x}^{(k)}_{j-1}[i]$, and

$\mathbf{x}^{(k)}_j[i] = \mathbf{x}^{(k)}_{j-1}[i] - \hat{\mathbf{u}}^{(k)}_j[i]\, d^{(k)}_j[i]$ <u>,where $d_1[i] = \mathbf{u}_1^\dagger \mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N-1)$ – dimensional process with the signal removed</u>;

computing $(j+1)th$ stage basis vector $\underline{\hat{\mathbf{u}}^{(k)}_{j+1}[i]}$,

$\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_j d_j}[i] = (1-\alpha)\,\hat{\mathbf{r}}^{(k-1)}_{\mathbf{x}_j d_j}[i] + \mathbf{x}^{(k)}_j[i] d^{(k)}_j[i]^*$ <u>,where $\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]$ is estimate of cross-correlation vector $\mathbf{r}_{x1d1}$</u>,

$\cancel{\hat{\delta}^{(k)}_{j+1}[i] = \left\|\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_j d_j}[i]\right\|}$,

$$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]}$$, wherein $\underline{\hat{\delta}_{j+1}^{(k)}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\right\|}$ <u>and</u> α is a time

constant;

applying <u>Mth error signal</u> $\epsilon_M^{(k)}[i] = d_M^{(k)}[i]^\dagger = \hat{\mathbf{u}}_M^{(k)}[i]^\dagger \mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, estimating variance of <u>error signal</u> $\epsilon_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\epsilon_j}^{(k)})^2[i] = (1-\alpha)\hat{\xi}_j^{(k-1)}[i] + \left|\epsilon_j^{(k)}[i]\right|^2 ;$$

computing *jth* scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]}$$; and

computing $(j-1)$th error signal $\epsilon_{j-1}^{(k)}[i]$

$$\epsilon_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \epsilon_j^{(k)}[i]$$; wherein output at time *k*th is

$y^{(k)}[i] = \epsilon_1^{(k)}[i]$.

9. (Original) An adaptive near-far resistant receiver for an asynchronous wireless system comprising:

means for receiving an asynchronous data vector including a spreading code;

using the received asynchronous data vector, means for updating weight coefficients of an adaptive filter without prior knowledge of synchronization of the spreading code of the data vector;

using the updated weight coefficients, means for determining synchronization of the spreading code; and

means for demodulating the output of the filter using the determined synchronization of the spreading code for obtaining a filtered data vector.

10. (Currently Amended) The receiver of claim 9, further comprising means for dividing the received asynchronous data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

11. (Currently Amended) The receiver of claim 10, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^{\mathbf{t}} \\ \mathbf{B}_1 \end{bmatrix}, \qquad (16)$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^{\mathbf{t}}\mathbf{s}_1}$, $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17)

12. (Currently Amended) The receiver of claim 9, wherein the means for determining the synchronization of the spreading code comprises:

means for computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left|\mathrm{Re}\{y[\hat{i}]\}\right| = \max_{k\in\{0,1,\ldots,NS-1\}} \left|\mathrm{Re}\{y[i-k]\}\right| \qquad (30c),$$

where $y[i] = \mathbf{w}[i]^{\mathbf{t}}\,\mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood ratio tests in the set $Y[i]$ given by $Y[i] = \{\ |\mathrm{Re}\{y[i]\}|, \ldots, |\mathrm{Re}\{y[i-NS+1]\}|\ \}$, where N is number of chips in the spreading code and S is number of samples per chip time ,and $W[i]^t$ is a tap-weights' vector.

13. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

means for applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$;

means for applying $\hat{\mathbf{B}}_1 = \mathbf{I} - \hat{\mathbf{u}}_j\hat{\mathbf{u}}_j^{\dagger}$,where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^{\dagger}\mathbf{s}_1}$., $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17);

for $j = 1$ to $(M - 1)$, means for computing d_j and $\mathbf{x}_j$

$$\mathbf{d}_j^{\dagger}[i] \triangleq [\hat{d}_j^{(1)}[i], \ldots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{\dagger}[i]\,\mathbf{X}_{j-1}[i],$$

$$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \ldots, \mathbf{x}_j^{(L)}[i]] = \hat{\mathbf{B}}_j[i]\,\mathbf{X}_{j-1}[i]$$,where $d_1[i] = \mathbf{u}_1^{\dagger}\mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N - 1)$ – dimensional process with the signal removed;

means for computing $(j+1)$th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}_j^{(m)}[i]d_j^{(m)}[i]^* = \frac{1}{L}\mathbf{X}_j[i]\,\mathbf{d}_j[i]$$, where $\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]$ is estimate of cross-correlation vector $\mathbf{r}_{x1d1}$,

$$\cancel{\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|}$$

$$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}$$, where $\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|$;

means for computing $(j+1)$th blocking matrix $\hat{\mathbf{B}}_{j+1}$

$$\hat{\mathbf{B}}_{j+1}[i] = \mathbf{I} - \hat{\mathbf{u}}_{j+1}[i]\hat{\mathbf{u}}_{j+1}^{\dagger}[i]\ ;$$

means for computing $d_M^{(m)}[i]$ and set it equal to <u>Mth error signal</u> $\in_M^{(m)}[i]$

$$\mathbf{d}_M^{\dagger}[i] \triangleq [\hat{d}_M^{(1)}[i], \ldots, \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^{\dagger}[i] = \hat{\mathbf{u}}_M^{\dagger}[i]\, \mathbf{X}_{M-1}[i] \; ;$$

means for applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i], \; \hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i]\hat{\delta}_M[i];$

for $j = (M-1)$ to 2, means for estimating variance of $d_j[i]$

$$\hat{\sigma}_{d_j}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2 \; ;$$

means for estimate variance of <u>error signal</u> $\in_j$

$$\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i]\hat{\delta}_{j+1}^2[i] \text{ ; and}$$

means for computing *j*th scalar Wiener filter $\hat{\omega}_j[i]$

$$\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]} \; .$$

14. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for applying $\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]]$,wherein L is number of independent samples of an observation vector $\mathbf{x}^{(m)}[i]$ and s_1 is a designated sender's spreading code;

means for applying $\hat{\mathbf{u}}_1 = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$ and $\mathbf{x}_0[i] = \mathbf{x}[i]$ <u>,where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^{\dagger}\mathbf{s}_1}$., $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0.(17)$</u>;

for j = 1 to (M −1), means for computing d_j and $\mathbf{x}_j$

$$d_j[i] = \hat{\mathbf{u}}_j^{\dagger}[i]\, \mathbf{x}_{j-1}[i]$$

$$\mathbf{x}_j[i] = \mathbf{x}_{j-1}[i] - \hat{\mathbf{u}}_j[i]\, d_j[i]$$

$\mathbf{d}_j^{\dagger}[i] \triangleq [\hat{d}_j^{(1)}[i], \ldots, \hat{d}_j^{(L)}[i]] = \hat{\mathbf{u}}_j^{\dagger}[i]\, \mathbf{X}_{j-1}[i]$,

$\mathbf{X}_j[i] \triangleq [\mathbf{x}_j^{(1)}[i], \ldots, \mathbf{x}_j^{(L)}[i]] = \mathbf{X}_{j-1}[i] - \hat{\mathbf{u}}_j[i]\, \mathbf{d}_j^{\dagger}[i]$,where $d_1[i] = \mathbf{u}_1^{\dagger}\mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N-1)$-dimensional process with the signal removed;

means for computing $(j+1)$th stage basis vector $\hat{\mathbf{u}}_{j+1}[i]$,

$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}_j^{(m)}[i] d_j^{(m)}[i]^{*} = \frac{1}{L}\mathbf{X}_j[i]\, \mathbf{d}_j[i]$,where $\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]$ is estimate of cross-correlation vector $\mathbf{r}_{x1d1}$,

$\cancel{\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|}$

$\hat{\mathbf{u}}_{j+1}[i] = \frac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}_{j+1}[i]}$,where $\hat{\delta}_{j+1}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]\right\|$;

means for computing $d_M^{(m)}[i]$ and set it equal to Mth error signal $\in_M^{(m)}[i]$

$\mathbf{d}_M^{\dagger}[i] \triangleq [\hat{d}_M^{(1)}[i], , \hat{d}_M^{(L)}[i]] = \mathbf{e}_M^{\dagger}[i] = \hat{\mathbf{u}}_M^{\dagger}[i]\, \mathbf{X}_{M-1}[i]$;

means for applying $\hat{\sigma}_{d_M}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_M^{(m)}[i]\right|^2 = \hat{\xi}_M[i]$, $\hat{\omega}_M[i] = \hat{\xi}_M^{-1}[i]\hat{\delta}_M[i]$;

for $j = (M-1)$ to 2, means for estimating variance of $d_j[i]$, $\hat{\sigma}_{d_j}^2[i] = \frac{1}{L}\sum_{m=1}^{L}\left|\hat{d}_j^{(m)}[i]\right|^2$

;

means for estimating variance of error signal $\in_j$, $\hat{\xi}_j[i] \triangleq \hat{\sigma}_{\in_j}^2[i] = \hat{\sigma}_{d_j}^2[i] - \hat{\xi}_{j+1}^{-1}[i]\hat{\delta}_{j+1}^2[i]$; and

means for computing jth scalar Wiener filter by $\hat{\omega}_j[i]$, $\hat{\omega}_j[i] = \frac{\hat{\delta}_j[i]}{\hat{\xi}_j[i]}$.

15. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data and updates weight coefficients further comprises:

for $k = 1$ to n, means for applying

$\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_0 d_0}[i] = \mathbf{s}_1$, $\hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$, and $\hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|$, wherein $\mathbf{x}_0^{(k)}[i]$ is the received asynchronous data vector, s_1 is a designated sender's spreading code, and k is kth clock time, where $k=1$ is the first time the data is observed ;

for $j=1$ to $(M-1)$, means for applying

$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^\dagger\, \mathbf{x}_{j-1}^{(k)}[i]$, and

$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i]\, d_j^{(k)}[i]$,where $d_1[i] = \mathbf{u}_1^\dagger \mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N-1)$ – dimensional process with the signal removed;

means for computing $(j+1)th$ stage basis vector $\hat{\mathbf{u}}_{j+1}^{(k)}[i]$,

$\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_j d_j}[i] = (1-\alpha)\,\hat{\mathbf{r}}^{(k-1)}_{\mathbf{x}_j d_j}[i] + \mathbf{x}_j^{(k)}[i] d_j^{(k)}[i]^*$,where $\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]$ is estimate of cross-correlation vector $\mathbf{r}_{x1d1}$,

$\cancel{\hat{\delta}^{(k)}_{j+1}[i] = \left\|\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_j d_j}[i]\right\|}$,

$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \frac{\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_j d_j}[i]}{\hat{\delta}^{(k)}_{j+1}[i]}$, wherein $\hat{\delta}^{(k)}_{j+1}[i] = \left\|\hat{\mathbf{r}}^{(k)}_{\mathbf{x}_j d_j}[i]\right\|$ and α is a time constant;

means for applying $\epsilon_M^{(k)}[i] = d_M^{(k)}[i]^\dagger = \hat{\mathbf{u}}_M^{(k)}[i]^\dagger\, \mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, means for estimating variance of error signal $\epsilon_j^{(k)}[i]$

$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}^{(k)}_{\epsilon_j})^2[i] = (1-\alpha)\,\hat{\xi}_j^{(k-1)}[i] + \left|\epsilon_j^{(k)}[i]\right|^2$;

means for computing jth scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$$\hat{\omega}_j^{(k)}[i] = \frac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]}$$; and

means for computing $(j-1)$th error signal $\in_{j\text{-}1}^{(k)}[i]$

$\in_{j\text{-}1}^{(k)}[i] = d_{j\text{-}1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \in_j^{(k)}[i]$; wherein output at time kth is $y^{(k)}[i] = \in_1^{(k)}[i]$.

16. (Currently Amended) The receiver of claim 9, wherein the means for using the received asynchronous data vector, to update weight coefficients further comprises:

means for computing maximum likelihood estimator for covariance matrix $\mathbf{R}_{\mathrm{x}}[i]$

$$\hat{\mathbf{R}}_{\mathrm{x}}[i] = \frac{1}{L}\sum_{m=1}^{L}\mathbf{x}^{(m)}[i]\mathbf{x}^{(m)*}[i] = \frac{1}{L}\mathbf{X}_0[i]\mathbf{X}_0^{\dagger}[i].$$

wherein, $\mathbf{x}^{(m)}[i]$ is an observation vector at a sampling time iT_s of the mth symbol, L is the number of independent samples of the observation vector $\mathbf{x}^{(m)}[i]$ for the initial acquisition of detector parameters, and the data is given in matrix form by

$$\mathbf{X}_0[i] \triangleq [\mathbf{x}^{(1)}[i], \ldots, \mathbf{x}^{(L)}[i]] ;$$

means for computing estimate of $\mathbf{R}_{\mathrm{x}_1}[i]$

$$\hat{\mathbf{R}}_{\mathrm{x}_1}[i] = \mathbf{B}_1\hat{\mathbf{R}}_{\mathrm{x}_1}[i]\mathbf{B}_1^{\dagger} = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^{\dagger}[i]\mathbf{B}_1^{\dagger}$$

and estimate of cross-correlation vector $\mathbf{r}_{x1d1}$ as, $\hat{\mathbf{r}}_{\mathrm{x}_1 d_1} = \mathbf{B}_1\hat{\mathbf{R}}_{\mathrm{x}}[i]\mathbf{s}_1 = \frac{1}{L}\mathbf{B}_1\mathbf{X}_0[i]\mathbf{X}_0^{\dagger}[i]\mathbf{s}_1$

means for computing $\mathbf{w}_{\mathrm{GSC}}^{\dagger}[i] = \mathbf{r}_{\mathrm{x}_1 d_1}^{\dagger}[i]\mathbf{R}_{\mathrm{x}_1}^{-1}[i]$ (29);

means for estimating $\hat{b}_1 = \mathbf{sgn}((\mathbf{u}_1^{\dagger} - \mathbf{w}_{\mathrm{GSC}}^{\dagger}[\hat{i}]\mathbf{B}_1)\mathbf{x}[\hat{i}])$ (35) , wherein $\mathbf{u}_1^{\dagger} - \mathbf{w}_{\mathrm{GSC}}^{\dagger}[i]\mathbf{B}_1$ (30a) is a weight vector; and

means for computing output $y[i] = (\mathbf{u}_1^{\dagger} - \mathbf{w}_{\mathrm{GSC}}^{\dagger}[i]\mathbf{B}_1)\mathbf{x}[i]$. (30b).

17. (Original) A digital signal processor having stored thereon a set of instructions including instructions for filtering interference and noise of an asynchronous wireless signal, when executed, the instructions cause the digital signal processor to perform the steps of:

receiving an asynchronous data vector including a spreading code;

using the received asynchronous data vector, updating weight coefficients of an adaptive filter without prior knowledge of synchronization of the spreading code of the data vector;

using the updated weight coefficients information data bits to determine the synchronization of the spreading code of the data vector; and

demodulating the output of the filter using the determined synchronization of the spreading code of the data vector for obtaining a filtered data vector.

18. (Currently Amended) The digital signal processor of claim 17, further comprising instructions for dividing the received asynchronous data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

19. (Currently Amended) The digital signal processor of claim 18, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^t \\ \mathbf{B}_1 \end{bmatrix}, \qquad (16)$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^t\mathbf{s}_1}$, $[.]^T$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17)

20. (Currently Amended) The digital signal processor of claim 17, wherein the instructions for determining synchronization comprises instructions for:

computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left|\mathrm{Re}\{y[\hat{i}]\}\right| = \max_{k\in\{0,1,\ldots,NS-1\}} \left|\mathrm{Re}\{y[i-k]\}\right| \qquad (30c),$$

where $y[i] = \mathbf{w}[i]^{t}\,\mathbf{x}[i]$ is filtered output from a likelihood test at clock time I detecting sequentially maximum of all likelihood tests in the set $Y[i]$ given by

$Y[i] = \{\,|\mathrm{Re}\{y[i]\}|,\ldots,|\mathrm{Re}\{y[i-NS+1]\}|\,\}$, where N is number of chips in the spreading code and S is number of samples per chip time<u>, and $W[i]^t$ is a tap-weights' vector</u>.

21. (Original) An adaptive receiver for filtering interference and noise of an asynchronous wireless signal comprising:

means for receiving an asynchronous data vector including information data bits;

means for updating weight coefficients of an adaptive filter without a prior knowledge of synchronization of the information data bits;

using the updated weight coefficient, means for determining the start of the information data bits; and

means for demodulating the output of the adaptive filter.

22. (Original) The adaptive receiver of claim 21, further comprising means for dividing the data vector represented by $\mathbf{x}[i]$ into two channels $\mathbf{x}_1[i]$ and $d_1[i]$ using a transformation $\mathbf{T}_1$ on $\mathbf{x}[i]$, represented by $\mathbf{T}_1\mathbf{x}[i]$, wherein the transformed data vector $\mathbf{x}[i]$ does not contain information about a designated sender's spreading code s_1, and $d_1[i]$ contains primarily only information about the spreading code s_1 and residual data from correlation of s_1 and $\mathbf{x}[i]$.

23. (Currently Amended) The adaptive receiver of claim 22, wherein the transformation $\mathbf{T}_1$ is defined by

$$\mathbf{T}_1 = \begin{bmatrix} \mathbf{u}_1^t \\ \mathbf{B}_1 \end{bmatrix}, \tag{16}$$

where $\mathbf{B}_1$ is a blocking matrix whose rows are composed of any orthonormal basis set of the nullspace of the normalized signal vector $\mathbf{u}_1 = \mathbf{s}_1/\sqrt{\mathbf{s}_1^t\mathbf{s}_1}$, $\underline{[.]^T}$ denotes matrix transpose, and where $\mathbf{B}_1\mathbf{u}_1 = \mathbf{B}_1\mathbf{s}_1 = 0$. (17)

24. (Currently Amended) The adaptive receiver of claim 21, wherein the means for determining the start of the information data bits comprises means for:

computing $\hat{i}$, the time occurrence of the information data bit, from the equation;

$$\left|\mathrm{Re}\{y[\hat{i}]\}\right| = \max_{k\in\{0,1,\ldots,NS-1\}} \left|\mathrm{Re}\{y[i-k]\}\right| \qquad (30c),$$

where $y[i] = \mathbf{w}[i]^t\mathbf{x}[i]$ is filtered output from a likelihood ratio test at clock time i detecting sequentially maximum of all likelihood ratio tests in the set $Y[i]$ given by

$Y[i] = \{\ \left|\mathrm{Re}\{y[i]\}\right|, \ldots, \left|\mathrm{Re}\{y[i-NS+1]\}\right|\ \}$, where N is number of chips in the spreading code and S is number of samples per chip time,<u>and $W[i]^t$ is a tap-weights' vector</u>.

25. (Currently Amended) The adaptive receiver of claim 21, wherein the means for determining the start of the information data bits comprises:

for $k = 1$ to n, means for applying

$\hat{\mathbf{r}}_{\mathbf{x}_0 d_0}^{(k)}[i] = \mathbf{s}_1$, $\hat{\mathbf{u}}_1^{(k)}[i] = \frac{\mathbf{s}_1}{\|\mathbf{s}_1\|}$, and $\hat{\delta}_1^{(k)}[i] = \|\mathbf{s}_1\|$, wherein $\mathbf{x}_0^{(k)}[i]$ is the received <u>asynchronous</u> data vector, s_1 is a designated sender's spreading

code, and k is kth clock time, where $k=1$ is the first time the data is observed ;

for $j=1$ to $(M-1)$, means for applying

$d_j^{(k)}[i] = \hat{\mathbf{u}}_j^{(k)}[i]^{\dagger}\,\mathbf{x}_{j-1}^{(k)}[i]$, and

$\mathbf{x}_j^{(k)}[i] = \mathbf{x}_{j-1}^{(k)}[i] - \hat{\mathbf{u}}_j^{(k)}[i]\,d_j^{(k)}[i]$,where $d_1[i] = \mathbf{u}_1^{\dagger}\mathbf{x}[i]$ is a signal-plus-noise scalar process and $\mathbf{x}_1[i] = \mathbf{B}_1\mathbf{x}[i]$, is an $(N-1)$ – dimensional process with the signal removed;

means for computing $(j+1)th$ stage basis vector $\hat{\mathbf{u}}_{j+1}^{(k)}[i]$,

$\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i] = (1-\alpha)\,\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k-1)}[i] + \mathbf{x}_j^{(k)}[i]\,d_j^{(k)}[i]^{*}$,where $\hat{\mathbf{r}}_{\mathbf{x}_j d_j}[i]$ is estimate of cross-correlation vector $\mathbf{r}_{x1d1}$,

~~$\hat{\delta}_{j+1}^{(k)}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\right\|$~~,

$\hat{\mathbf{u}}_{j+1}^{(k)}[i] = \dfrac{\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]}{\hat{\delta}_{j+1}^{(k)}[i]}$, wherein $\hat{\delta}_{j+1}^{(k)}[i] = \left\|\hat{\mathbf{r}}_{\mathbf{x}_j d_j}^{(k)}[i]\right\|$ and α is a time constant;

means for applying Mth error signal $\epsilon_M^{(k)}[i] = d_M^{(k)}[i]^{\dagger} = \hat{\mathbf{u}}_M^{(k)}[i]^{\dagger}\,\mathbf{x}_{M-1}^{(k)}[i]$;

for $j = M$ to 2, means for estimating variance of error signal $\epsilon_j^{(k)}[i]$

$$\hat{\xi}_j^{(k)}[i] = (\hat{\delta}_{\epsilon_j}^{(k)})^2\,[i] = (1-\alpha)\,\hat{\xi}_j^{(k-1)}[i] + \left|\epsilon_j^{(k)}[i]\right|^2 ;$$

means for computing jth scalar Wiener filter $\hat{\omega}_j^{(k)}[i]$

$\hat{\omega}_j^{(k)}[i] = \dfrac{\hat{\delta}_j^{(k)}[i]}{\hat{\xi}_j^{(k)}[i]}$; and

means for computing $(j-1)$th error signal $\epsilon_{j-1}^{(k)}[i]$

$\in_{j-1}^{(k)}[i] = d_{j-1}^{(k)}[i] - \hat{\omega}_j^{(k)}[i]^* \in_j^{(k)}[i]$; wherein output at time *k*th is $y^{(k)}[i] = \in_1^{(k)}[i]$.